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Insects That Attack Mesquite (*Prosopis* spp.) in Argentina and Paraguay

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Insects That Attack Mesquite (*Prosopis* spp.) in Argentina and Paraguay

Their Possible Use for Biological Control in the United States

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Introduction

Mesquites (*Prosopis* spp.) are thorny, leguminous trees or shrubs that infest 38 million ha of rangeland in Southwestern United States (Platt 1959) and large additional areas in northern Mexico. The most dense stands are found through central Texas between isohyets of 457 and 710 mm of annual rainfall; the northern limit coincides with a mean January temperature of 0°C (Bogusch 1951), and the eastern distribution is probably limited by soil factors (Peacock and McMillan 1965).

A large body of literature documents the great losses that the grazing livestock industry sustains because of mesquite competing with desirable forage plants for water (DeLoach, in press). The dense mesquite thickets also increase the cost of managing livestock. Direct losses to the grazing livestock industry were estimated at \$250 to \$500 million annually in the United States (plus an unknown amount in Mexico), not including the value of water lost to other agricultural, industrial, or urban uses. In the more arid areas of southwestern North America, mesquite appears to contribute to soil erosion, sand dune formation, and desertification. However, mesquite also has several beneficial values. It is used for ornamental shade trees; the pods are eaten by livestock; the wood is used for barbecue wood, charcoal, firewood, fenceposts, parquet flooring, and crafts; and the flowers are an excellent source of nectar for honey production. Present damage caused in the United States is probably 20–30 times greater than present beneficial values (DeLoach, in press).

Mesquite constitutes as much as 10 to 25 percent of the diet of seven species of small mammals and birds, especially of jackrabbits and rodents that are themselves damaging to rangelands. Among clearly beneficial species, only the Gambel quail is likely to be reduced in population by mesquite control. Intensive cultivation of mesquite has recently been suggested to produce biomass to fuel commercial electric generating plants. Also, its potential for nitrogen fixation may be of value in rangelands or in the ecosystem. Research on these aspects is in the early stages, and these potential benefits of mesquite are difficult to evaluate at this time (DeLoach, in press).

Present chemical or mechanical controls are relatively expensive because of the low value-per-acre return in this semiarid area, where 6–10 ha or more are required to produce one animal-unit (Scifres et al. 1973). Aerial applica-

tion of the herbicide 2,4,5-T was the most economical treatment in Texas, resulting in an average annual rate of return of 15.9 percent and the need for 8.5 years to recover the investment capital; the corresponding figures for the next best herbicide, dicamba, were 11.4 percent and 16 years (Whitson and Scifres 1980). Even 2,4,5-T was not economical for light stands of mesquite, and in some areas it was economical only for dense stands on deep soils. None of the mechanical treatments resulted in the 9 percent per year return on the investment needed to break even (Whitson and Scifres 1980). The new herbicides, triclopyr and chlorpyralid, that have replaced 2,4,5-T are more effective but are also more expensive.

In contrast, biological control by introduced foreign insects offers the prospect of permanent control and benefit-cost ratios that typically range from an estimated 50:1 to more than 1,000:1 (Andres 1977). Although most previous attempts at biological control using foreign organisms have been directed against introduced weeds, control of the native mesquites is promising because we have found many natural enemies attacking several species of *Prosopis* in southern South America; with more testing, these natural enemies could be candidates for introduction (DeLoach 1978, 1980). Possible candidate insects for introduction also occur in parts of Asia on *Prosopis farcta* (Solander ex Russell) Macbride. Gerling and Kugler (1973) found 69 species of phytophagous insects in Israel, the most important of which were insects that fed on fruit or seed. Ward et al. (1977) listed 26 species of insects from *Prosopis* spp. in Asia and North Africa.

Two species of mesquite are major pests of rangelands in the United States. Honey mesquite, *P. glandulosa* Torrey var. *glandulosa*, occurs from eastern Texas to northeastern Mexico, in western Oklahoma, and in southern New Mexico; western honey mesquite, *P. glandulosa* var. *torreyana* (Benson) Johnston, occurs from western Texas to southern California; and running mesquite, *P. glandulosa* var. *prostrata* Burkart, occurs in southern Texas. The second species, *P. velutina* Wooton, is a major pest in Arizona and Sonora, Mexico. Four other species occur in Mexico, *P. laevigata* (Humboldt and Bonpland ex Willdenow) M.C. Johnston, *P. juliflora* (Swartz) DC., *P. articulata* S. Watson, and *P. tamaulipana* Burkart (Johnston 1962, Burkart 1976). One other species, *P. alba* Grisebach, was introduced from Argentina into the United States as an ornamental probably 20–30 years ago by unknown means. All of these species are in section Algarobia, series Chilenses, of the genus except *P. articulata* and *P. tamaulipana*, which are in series Pallidae.

In addition, three species of screwbean mesquites in section *Strombocarpa* occur in North America: *P. pubescens*

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Bentham grows along streams and waterholes from western Texas to southern California and northern Mexico, *P. palmeri* S. Watson in Baja California, and *P. reptans* Bentham var. *clerascens* (A. Gray) Burkart in south Texas and adjoining Mexico. These species are weedy only in localized areas (Johnston 1962, Burkart 1976, Simpson 1977, Isley 1973). Carman and Mabry (1975) suggested that the North American species came by long-range migration from South America on at least three separate occasions: (1) the ancestor of the species in section *Algarobia*, (2) the ancestor of the screwbeans *P. pubescens* and *P. palmeri*, and (3) *P. reptans*, possibly a recent introduction by the early European explorers.

The genus *Prosopis* has had its greatest evolutionary development in semiarid regions of southern South America, where 31 species occur, the center of diversity being in Argentina (Burkart 1976). The South American species most similar to the North American weedy species are *P. chilensis* (Molina) Stuntz emend. Burkart, *P. nigra* (Grisebach) Hieronymus, *P. caldenia* Burkart, *P. flexuosa* DC., *P. alpataco* R.A. Philippi, *P. alba* Grisebach, and *P. pugionata* Burkart (fig. 1); all of these species are in section *Algarobia*, series *Chilenses* (Burkart 1976).

Ward et al. (1977) reported 112 species of phytophagous insects, some of which had been collected in Argentina by C.R. Ward and E.W. Huddleston in the late 1960's and others of which had been documented in various museum and literature records. We conducted extensive explorations from this laboratory into Argentina and Paraguay from 1976 to 1981 to find additional insects that might be useful for biological control. Argentine scientists provided information on additional species that attack these plants.

This report presents our estimates of the abundance of the various insects we collected, their importance in damaging the plant, and their relative value for biological control.

Materials and Methods

In South America, the main area of distribution of *Prosopis* is along the semiarid eastern slopes of the Andes Mountains and in the plains to the eastward, in the Chaco and Monte phytogeographical regions of Argentina and Paraguay (Burkart 1976, Cabrera 1976). The elevation varies from near sea level in the south and along the Río Paraná to 3000 m in the north and west.

The climate in this area is generally similar to that of northern Mexico and the southwestern area of the United States where mesquite occurs. The western area has mostly summer rainfall; moderate to hot summers and mild to cold winter temperatures, depending on the elevation; and high annual water deficits. The climate in these areas

of both North and South America belongs to world climate zones 7, 2, and 3, as described by Walter et al. (1975). Type 7 is the arid temperate climate of continental regions, with low rainfall and strong contrasts between summer and winter. Type 2 has a tropical-rainfall climate with prolonged droughts in winter. Type 3 is typical for the subtropical dry zone of deserts, with extreme variation between day and night and annual precipitation of less than 200 mm. In Argentina, the mesquite distribution is in areas with climates ranging from type 7 to type 2. In the United States and Mexico, the range is also from type 7 to type 2, but type 3 predominates. The contrast between summer and winter is stronger than in Argentina. Because of these differences, few areas or points in North America have climates that are closely similar to those in areas of South America; however, since the vegetational physiognomy is similar in both areas, the climatic differences probably are not critical. Thus, in a broad sense, it is possible to say that the climate of Andalgalá, Catamarca, is similar to that of Ft. Stockton, TX; that of Mendoza is similar to that of the area from El Paso, TX, to Albuquerque, NM; that of Neuquén approximately matches the climate from southwestern California to western New Mexico (Socorro); and that of Santa Rosa and Bahía Blanca is similar to that of Del Rio, TX. Visual interpolation between locations in figures 2 and 3, suggests other areas with similar climates. For example, areas of central Chaco and Formosa Provinces would be similar to areas near Saltillo and Monterrey, Mexico.

We made 13 extensive exploratory trips into western and northern Argentina and western Paraguay between 1976 and 1981, traveling a total of 81,550 km in search of insects that attack various species of *Prosopis* (fig. 4). The first trip included extensive travel in southern Brazil in search of natural enemies of other weeds, but we found no *Prosopis*.

Collections were made by sweeping, by beating onto a sheet, by hand collecting, and by collecting the fruit and limbs of host plants for subsequent emergence of insects. Immature insects, especially foliage feeders, were held in clear plastic boxes during the trips and provided with fresh leaves every few days until they pupated so that we could obtain adults for identification.

Voucher specimens of the plants and insects collected are maintained at this laboratory and at the Systematic Entomology Laboratory, USDA-ARS, Beltsville, MD.

We have ranked the more promising species for biological control into three categories based on (1) degree of host specificity, (2) abundance and amount of damage caused, (3) degree of probable competition with native insects of

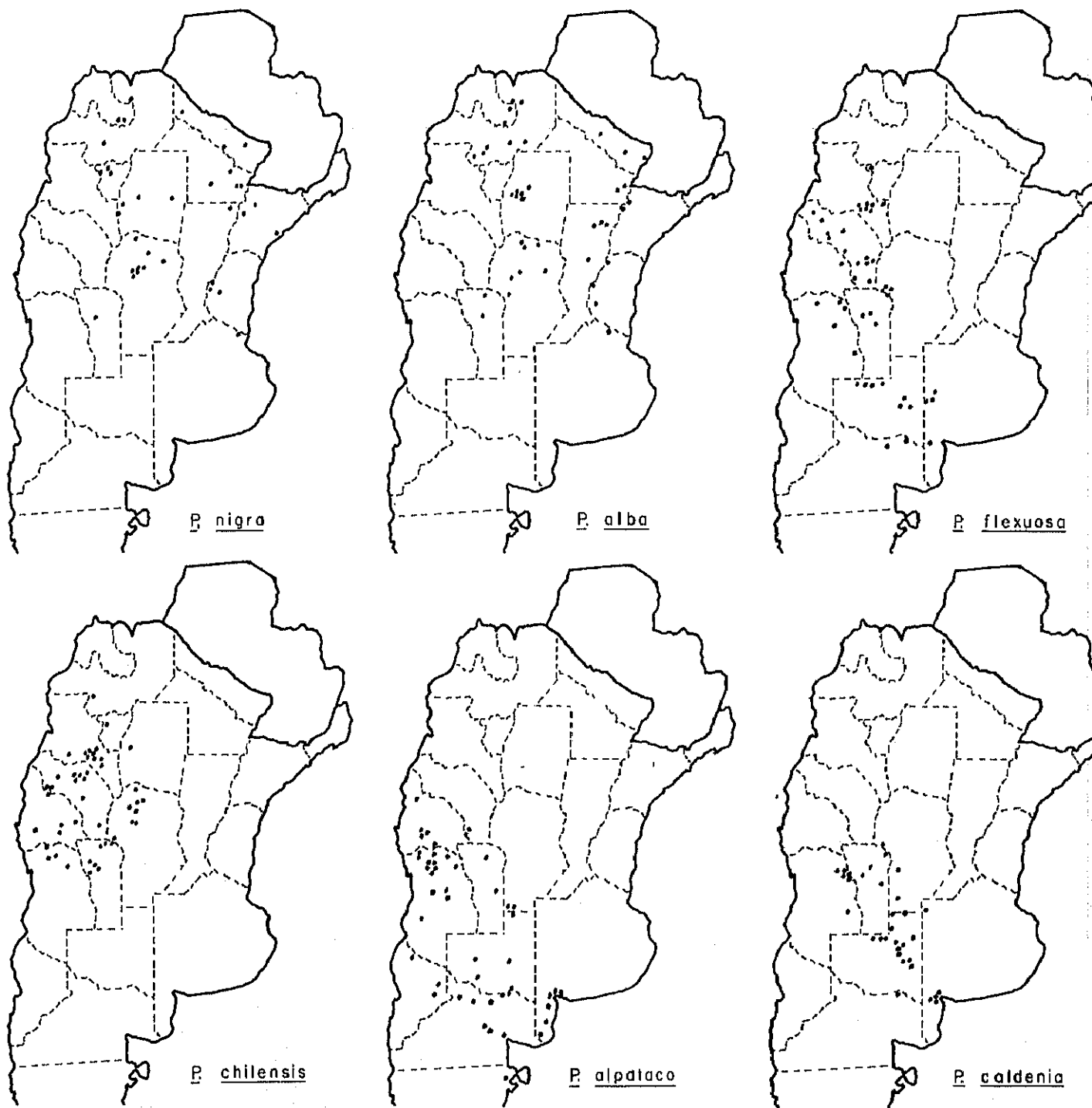


Figure 1
Distribution in Argentina of the six most abundant species of *Prosopis*, section Algarobia, series Chilenses, that are most closely related to the North American weedy species, *P. glandulosa* and *P. velutina* (Information from Burkart 1976).

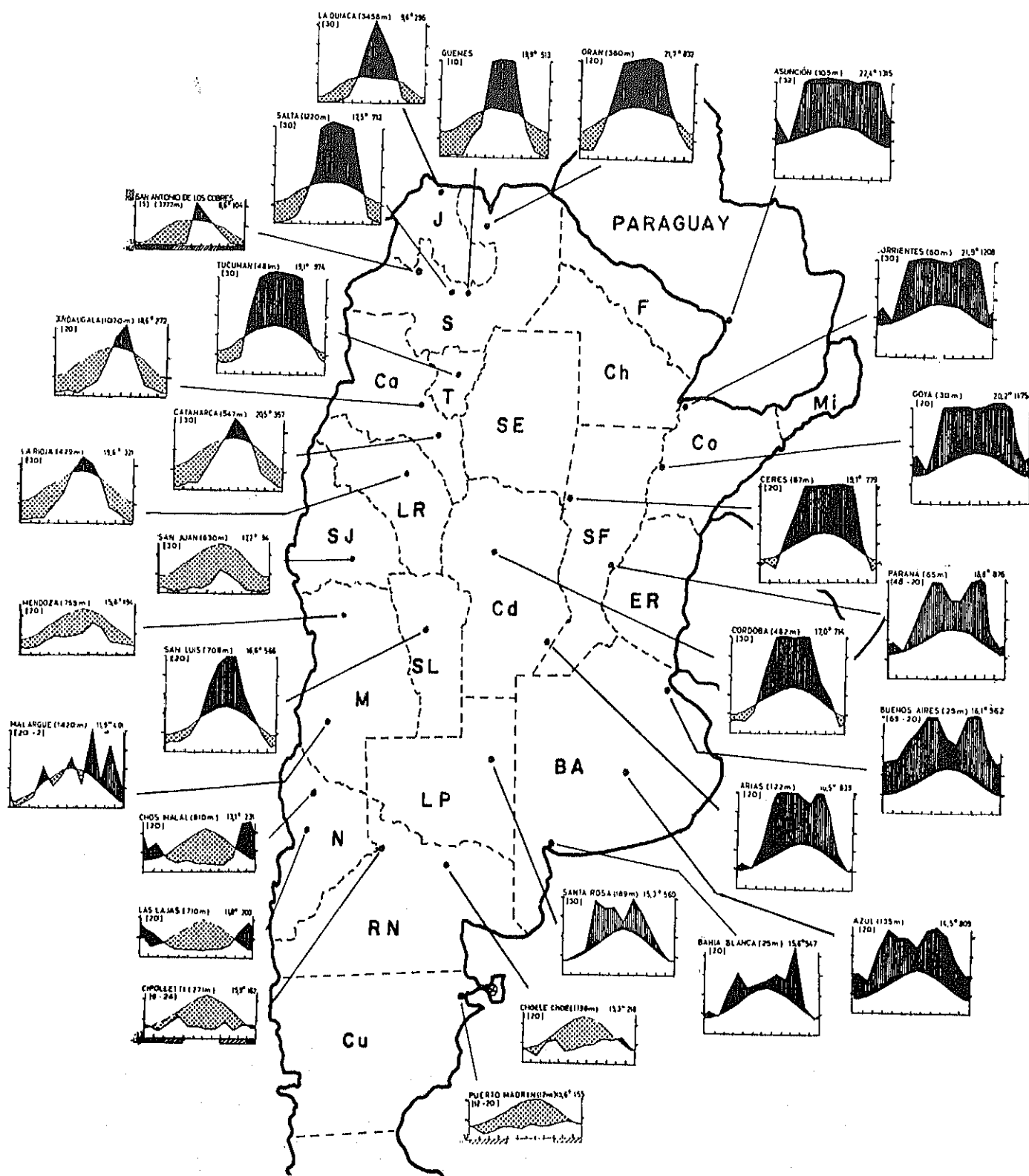


Figure 2
Climate diagrams of locations near collecting sites of *Prosopis* in Argentina and Paraguay (adapted from Walter et al. 1975). BA=Buenos Aires, Ca=Catamarca, Cd=Córdoba, Ch=Chaco, Co=Corrientes, Cu=Chubut, ER=Entre Ríos, F=Formosa, J=Jujuy, LP=La Pampa, LR=La Rioja, M=Mendoza, Mi=Missiones, N=Neuquén, RN=Río Negro, S=Salta, SE=Santiago del Estero, SF=Santa Fe, SL=San Luis, SJ=San Juan, T=Tucumán.

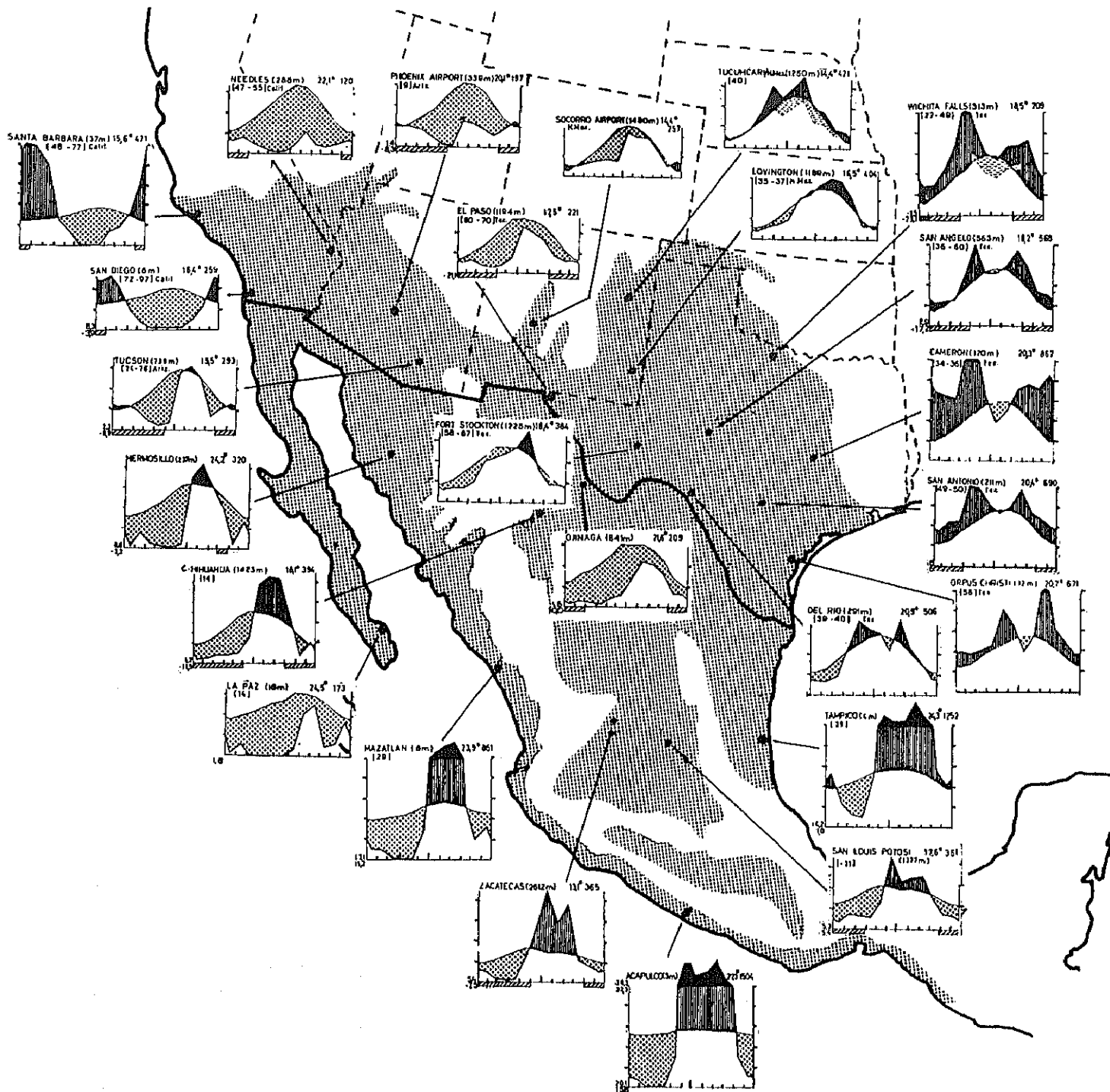


Figure 3
Climate diagrams of locations in North America (shaded area) where *Prosopis* occurs (adapted from Walter et al. 1975, Simpson 1977, and Johnston 1962).

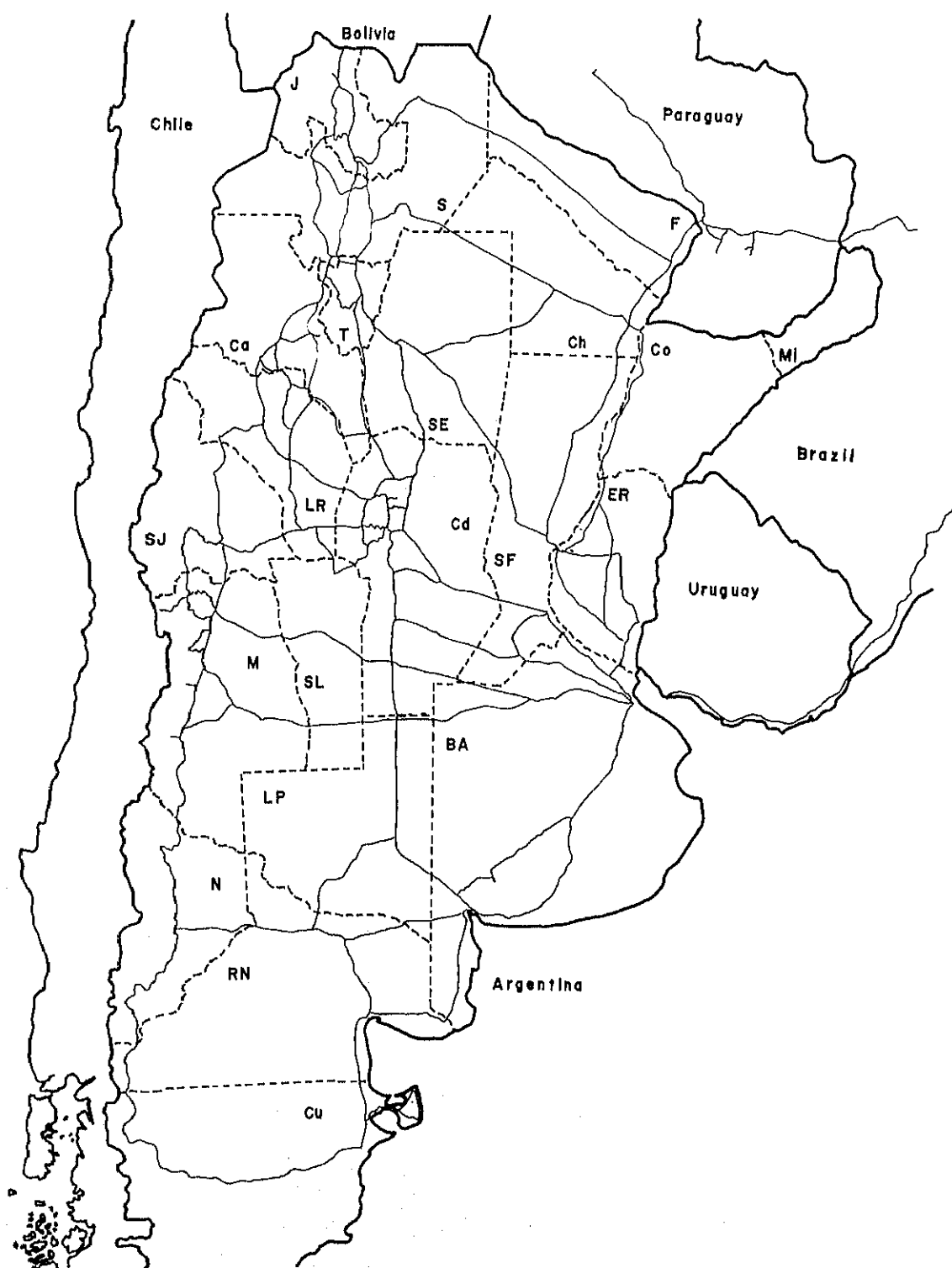


Figure 4
Routes followed by the authors in Argentina and Paraguay in search of natural enemies of mesquite, 1975-1981; province names are given in figure 1.

mesquite in North America, and (4) occurrence of other members of the insect genus in North America, which gives an indication of the probability that parasites, predators, or pathogens of native species might be able to transfer and attack the introduced species.

Results and Discussion

A total of 393 species of phytophagous insects and 1 mite species are now known to attack the various species of *Prosopis* in Argentina and Paraguay (table 1). The insects comprise 244 Coleoptera, 66 Lepidoptera, 37 Homoptera, 18 Hemiptera, 26 Diptera, 4 Hymenoptera, and 1 Thysanoptera (those identified as "spp." in table 1 being counted as 2 species). Of these, 105 had previously been reported by Ward et al. (1977). In addition, M. Viana provided names of 66 species of Coleoptera that attack mesquite, 41 of which had not been mentioned by Ward et al. (1977). Also, H. Erb (CIRPON, Tucumán, Argentina) provided names of a few species and biological information on others.

We collected 256 species from *Prosopis* in Argentina and Paraguay, 199 of which had not been mentioned by Ward et al. (1977), Viana, or other workers. The South American insect fauna that attacks weeds is not well known, and only 97 of the species we collected could be identified to the species level, including those labeled "near" or "probably." At least 20 new species were found, and more may be discovered as the specimens are studied in more detail.

Of the 256 species we collected, 99 species were collected at only 1 site on 1 occasion, and only 1, 2, or 3 specimens of each species were collected. We do not consider such low numbers to indicate an association with *Prosopis* or importance in control. Of the remaining, 77 of the more abundant species have been arranged in categories of probable importance in causing damage and in possible value as introductions for biological control (table 2).

Flower, Fruit, and Seed Feeders

The most desirable insects for introduction at the present time are those that attack the reproductive system of the plant. Such insects would slow or stop its spread as a weed but would not harm standing trees used as ornamentals or for other purposes.

We reared at least 14 species of Bruchidae from pods of *Prosopis* spp. In Argentina, at least 8 of which are new species recently described by Kingsolver (1982, 1983). Bruchids damaged (measured as exit holes in the endocarp) about one-third of the seeds of most species of *Prosopis* but notably less of *P. nigra*, *P. alata*, and the

screwbean, *P. strombulifera* (Lam.) Benth (table 3). Actual reduction in germination probably was much less than the proportion of seed damaged; we did not measure the degree of feeding on the seed itself or germination. The feeding by bruchid larvae often does not kill the seed; the embryo and a sufficient amount of the endosperm often remain to allow germination and growth of the seedling.

The genera *Rhipibruchus* (seven spp.), *Scutobrachus* (five spp.), and *Pectinibruchus* (one sp.) do not occur in North America and also appear to be restricted in host range to the genus *Prosopis* (Kingsolver et al. 1977). *Rhipibruchus picturatus*, *R. prosopis*, *R. psephenopygus*, *Scutobrachus ceratioborus*, *S. vinalicola*, *S. terani*, *S. curtitropis*, and *Pectinibruchus longiscutus* attacked species closely related to honey mesquite. Kingsolver et al. (1977) reported that *Acanthoscelides* spp. "j" and "k" also attack species closely related to honey mesquite. *Acanthoscelides longiscutus* attacked screwbean species closely related to *Prosopis reptans*. *Rhipibruchus prosopis* attacked species in both sections Algarobia and Strombocarpa. According to Ward et al. (1977), *Scutobrachus ceratioborus* (= *A. vagenotatus*) attacks several species of *Prosopis*, but we did not find it on species in section Strombocarpa. All of these are known to attack only *Prosopis* spp. except *Scutobrachus vinalicola* that we reared also from *Acacia caven* (tables 1 and 2). In addition, Kingsolver (personal communication) stated that *Amblycerus piurae* (Pierce) from Peru and Ecuador, *A. sallaei* (Jekel) from Venezuela, and *Algarobius* n. sp. from Colombia and Venezuela all attack *P. juliflora* and appear restricted to the genus *Prosopis*. Also, *Scutobrachus gastoi* Kingsolver attacks *P. tamarugo* in Chile. Any of these species would be good candidates for introduction. Mesquite is already heavily attacked in North America by native species of bruchids, which might severely compete with South American introductions. Careful laboratory investigation might reveal, however, that they can outcompete the native species to give better control in the United States.

We collected several species of tiny weevils of the genus *Apion* on mesquite by beating and sweeping. Some of these species develop in galls of other insects, but we found one species rather heavily attacking green pods. According to Erb (personal communication), the eggs of this species are laid in the succulent, green pods just before they reach full size and before the seed begin to enlarge; the larvae feed on the seed and nearly always kill them by eating the embryos. Thus, although they are much smaller, *Apion* cause more damage than bruchids. Erb stated that in some areas more than 90 percent of the seed were destroyed, but the occurrence of damage was sporadic. Erb has collected this species of *Apion* only on three species of *Prosopis*, *P. alba*, *P. nigra*, and *P. ruscifolia* Grisebach.

The taxonomy of the genus *Apion* is poorly understood, and none of our specimens were identified to species. Ward et al. (1977) reported that three species of *Apion* occur on *Prosopis* in the United States and Mexico; they reared one species from galls of other insects and one probably fed on seeds. This latter species might compete with the Argentine species if introduced, but the damage we observed in Argentina was much greater than that we have observed in the United States.

We collected five species of small *Sibinia* weevils on *Prosopis* spp., three of which were new species (Clark 1979). All probably feed on buds or seeds. *Sibinia mastuerzo* was common on *P. strombulifera* at one site and *S. tintilaco* on *P. torquata* at two sites; both would be candidates to control *P. reptans* in the United States. Only *S. concava* and *S. asuticifera* attacked species of *Prosopis* in series Chilenses, and both were scarce. Since species of this genus have not been found on mesquite in North America, they would be candidates for introduction. The amount of damage caused in Argentina has not yet been assessed.

The cerambycid *Lophopoeum timbouvae* was reported by Bosq (1943) to develop in the fruits of *Prosopis*, though we did not find it in our explorations. It also developed in fruit of *Enterolobium contortisiliquum*, a legume of tropical America and the West Indies but not of North America. Erb (personal communication) stated that larvae of *L. timbouvae* fed in the pods and that one larva usually killed several seeds, but the occurrence of damage in the field is localized and sporadic. We reared one species of cerambycid, *Leptostylus* prob. *phryssomimus*, from dry pods, but the species feeds only on the mesocarp of the fruit.

The pentatomid *Lobopomis peltifera* was observed feeding on green pods and probably causes considerable damage, but other species of pentatomids and coreids in Texas cause similar damage.

We reared the anobiid beetle *Tricorynus argentinus* from pods of *Prosopis*, especially of *P. caldenia*, but Viana stated that it also attacked *Cassia aphylla*. Also, Viana reported that *T. argentinus* and *T. subrutilliceps* fed on the beans of *P. alba* and *P. nigra*, but Bosq (1943) reported that the larvae of *T. subrutilliceps* bore in small branches. Other species of *Tricorynus* occur on mesquite in North America (Ward et al. 1977).

We reared the pyralid *Anypsisipyla univitella* from pods, particularly of *P. chilensis*, from several locations; but Costa Lima (1968) reported that it attacks *Enterolobium timbouva* and *Cassia brasiliensis*. Most of the pyralids are known to have wide host ranges, and some may have been contaminants in stored pods in the laboratory. Ward et al.

(1977) reported that the lycaenid *Leptotes trigemmatous* from Chile fed on the fruit, flowers, and seed of *P. tamarugo*; and we reared a phycitid and a tortricid from pods.

The thrips, *Frankliniella rodeos*, was reported by Erb (personal communication) to cause very heavy damage to mesquite flowers. He also reported that one species of Cecidomyiidae parasitized flower buds. Thrips and cecidomyiids also attack mesquite in North America (Ward et al. 1977).

Foliage Feeders

A few species of lepidopterous foliage feeders appear to be excellent candidates for introduction. A gelechiid leaf tier (tentatively determined as *Evippe* sp.) was abundant in Argentina and Paraguay in February and March; in March 1978 it had defoliated mesquite for many miles. R.W. Hodges (personal communication) stated that the species does not occur in North America. In Argentina, it attacked *Prosopis nigra* and *P. flexuosa*, and in Paraguay it attacked *P. affinis* Sprengel and *P. ruscifolia*. Other leaf-tying gelechiids (*Recurvaria-Aristotelia* group) were abundant on *P. alba* and *P. nigra*. We did not observe either species on other plants growing nearby.

A geometrid, *Nephodia marginata*, was reported by Hayward (1958) and Orfila (1966) to completely defoliate *Prosopis* over large areas in Argentina. No other hosts were recorded other than *Prosopis*. None of our specimens were identified as either of these species. We collected 17 species of geometrids that could not be identified, but we did not observe large-scale defoliation by any of them. We also found the geometrid *Narragodes* prob. *gyda* on *P. chilensis*, but it was not causing obvious defoliation. Cates and Rhoades (1977) reported that a species of *Semiothisa* attacked *P. torquata* and slightly attacked *P. chilensis* and *P. flexuosa* near Andalgalá, Catamarca Province; 32 percent of the total observations were on *Prosopis* (preference ranking=64 percent) and the rest on *Acacia* and *Cercidium*.

We observed bagworms of the genus *Oiketicus* causing severe defoliation of *P. chilensis* and *P. flexuosa* at several locations in Argentina. Ward et al. (1977) reported that *O. bergii* also attacked *Cassia aphylla* and that *O. westwoodii* attacked *Piptadenia cebil* and *P. communis*. None of these species occur in the United States, although other members of these plant genera do occur in the United States and Mexico. Ward et al. (1977) reported *O. horni* only from *Prosopis*, but we did not find it. *Oiketicus* is already represented by three species that attack mesquite in the United States and Mexico (Ward et al. 1977) but cause little damage.

Cates and Rhoades (1977) reported that three species of insects fed heavily on the foliage of *Prosopis* near Andalgalá. An undetermined species of noctuid fed entirely on *P. chilensis*, and 46 percent of the feeding of the noctuid *Melipotis bisinuata* was on *P. flexuosa* (mostly) and *P. chilensis* (preference ranking for *Prosopis* was 96 percent). Also, a sawfly, *Brachyphatnus* sp., fed entirely on *P. chilensis*.

We collected several species of chrysomelid beetles from mesquite, but none caused serious damage. Several are known to attack *Acacia caven*, and several are from genera represented on *Prosopis* in the United States. Five species of *Dachrys* and the related *Temnodachrys* and *Cylindrodachrys* are possibilities for introduction, but some of these species are known to attack other plants. The genera *Dinophtalma*, *Homotypus*, and *Monolepta* are not represented in the United States, and the species found in Argentina are not known to attack plants other than *Prosopis*. Viana stated that *Megalostomis* sp. nr. *consimilis* and *M. gazella* are widespread on *Prosopis*, although the latter also attacks *Acacia*. Bosq (1943) noted that *Ischiopachys cribripennis* is also widespread but also attacks *Acacia*.

The mite *Eriophyes* poss. *tenuis* damaged the foliage of *P. strombulifera*. Mites of this genus have a high probability of being host specific; and if species or biotypes also damage species of *Prosopis* series *Chilenses*, they would be good candidates for introduction.

Most adult Curculionidae fed on foliage but did not cause noticeable damage. The larvae of these species are probably more important as root or flower feeders; populations were usually at low levels.

We found species of Psyllidae near *Euphalerus* sp., and these were causing heavy damage to young foliage of several species of *Prosopis* at many locations in Argentina. Other species of Homoptera and Hemiptera might be good candidates for introduction, but not enough is known at present about their host ranges and effects on the plant to assess their importance. Some of these were frequently found, such as the cicadellids *Gypona paupercula*, *Polana obliqua*, and *Tapajosa doeringi*, and the membracids *Hebetica arechavaeleta*, *Smiliorachis* sp. nr. *concinna*, *S. proxima*, *Stictopelta acutula*, and *S. indeterminata*.

Branch and Trunk Borers

Several species of cerambycid beetles whose larvae bore into trunks and limbs, or that are twig girdlers, sporadically cause severe damage to *Prosopis* trees and could be good candidates for introduction when their host ranges are better known.

Both *Criodion cinereum* and *Torneutes pallidipennis* are large beetles (adults of the latter measure 7 by 2 cm) whose larvae can produce such severe tunneling in trunks that the tree dies or breaks off in the wind (Erb, personal communication); neither genus occurs in North America, but the latter also attacks *Acacia* trees. Erb has observed small outbreaks of *C. cinereum* that spread rapidly for 2 or 3 years before ceasing, probably halted by the attack of parasites. Viana (personal communication) stated that *Calocosmus morosus* bores in trunks and limbs (in large numbers according to Bosq 1943) and that *Alphus* sp. nr. *bruchi* and *Ranqueles mus* also bore in trunks, but the latter is rare; all three apparently attack only *Prosopis*. He also stated that *C. desmaresti* bores in trunks; but it also attacks *Geoffroea*, *Acacia caven*, and other leguminous plants, according to Hayward (1958).

Four species of *Achryson* bore in limbs—*A. lutarium* in large limbs and *A. surinamum*, *A. undulatum*, and *A. unicolor* in smaller limbs; however, *A. surinamum* also attacks *Acacia caven* and several other plant genera and already occurs in North America. Erb (personal communication) stated that *Brasilianus lacordairei* also bores in branches, but it also attacks the unrelated red quebracho tree, *Schinopsis quebracho-colorado* Schlecht. Hayward (1958) reported that *Cyllene spinifera* occurred on *P. alba* and bored in branches and trunks of *P. nigra*; Viana stated that it attacks several species of *Prosopis*, but it is not known to attack species of other genera.

Viana (personal communication) mentioned that *Lochmaeocles sladeni* girdles branches up to 5 cm in diameter and that *Odontocera flavicauda* girdles smaller branches; both are known to attack only *Prosopis*, but both genera occur in North America. Two other twig girdlers, *Oncideres germarii* and *O. guttulata*, also attack *Acacia* in addition to *Prosopis*; another member of the genus, *O. rhodosticta* Bates, attacks mesquite in Texas but girdles branches only up to about 2 cm in diameter.

Eleven species of buprestid beetles are reported to attack mesquite in Argentina. We found only two species, probably because we did not sample extensively inside the limbs or trunks. Most species are reported to have hosts other than *Prosopis* and most of the genera also are represented in North America. None of the buprestids appeared to be good candidates for introduction.

Kuschel (1945, 1950) reported that adults of the weevils *Cratosomus attenuatus* Emden and *C. luctuosus* Emden were abundant on *P. juliflora* (?) at Cochabamba, Bolivia. We did not collect these species, and the two species *C. helleri* and *C. fasciatopunctatus*, reported from Argentina, are not specific to *Prosopis*. Species of this genus of weevils are known to be trunk borers (D.R. Whitehead,

personal communication); several species occur in Mexico, but none occur in the United States.

We also found an anthribid beetle, *Anthribus* sp., on *P. alba* in Formosa Province. Ward et al. (1977) and Viana report several species of bostrichid beetles from various species of *Prosopis*. Ward et al. (1977) found the bostrichid *Xyloprista hexacantha* on *Prosopis*, but Hayward (1958) reported that it damaged agricultural crops. We do not know that any of these species attack the living parts of *Prosopis* or that they damage the plant.

Root Feeders

We collected adults of many species of weevils from *Prosopis* in Argentina and Paraguay by beating and sweeping. Most were broad-nosed weevils of the genera *Naupactus*, *Pantomorus*, *Pororrhynchus*, and *Promecops*. Little is known of the biology or host range of these weevils or of the biology of the North American broad-nosed weevils that attack mesquite, though the larvae of broad-nosed weevils usually feed on the roots of plants. The taxonomy of all these genera is poorly understood, and only a few specimens could be identified to species. Several of the genera collected from *Prosopis* in Argentina are not represented in North America, and some might be candidates for introduction if more were known of the host range and biology of the larvae.

Gall Formers

On two occasions we found *P. nigra* infested by tiny cynipid wasps, probably *Eschatocerus myriadeus*, once near Tinogasta, Catamarca, and once near Juyuy. The larvae infested the branches, causing elongated galls. As the galls grew, the bark ruptured on one side, exposing a bare area of cambium tissue typically one-third or more of the circumference of the galled branch. The gall and the terminal part of the branch then died. In old damage, many emergence holes of the wasps dotted the exposed, dead cambium layer of the gall. At both locations, a few trees were heavily attacked, with many dead branches, but nearby trees were not infested. Similar damage was reported by Jørgensen (1916).

We also found several species of *Prosopis* heavily infested with a variety of galls on the stems, petioles, and thorns. These galls seemed to cause little harm to the tree, and we did not obtain specimens of the organisms causing the galls. Jørgensen (1916) described the kinds of galls made by several species of Hymenoptera, Diptera, Lepidoptera, and Coleoptera in *P. alata*, *P. alba*, *P. torquata*, and *P. campestris*. No species of the cecidomyiid genus *Liebeliella*, *Neolasioptera*, *Rhopalomyia*, or *Tetradiplosis* listed in table 1 are known from *Prosopis* in North America (R.D. Gagné, personal communication).

Considerations in Control of Mesquite

Our discussion has thus far indicated that several South American insects are promising candidates for introduction. They include foliage feeders, borers of woody plant parts, and feeders of fruit and seed. The effectiveness of introduced control agents can be estimated only broadly before releases are actually made. Moreover, some limiting factors may be more serious in a project to control a native weed (such as mesquite) than in previous projects to control introduced weeds (DeLoach 1978). First, parasites, diseases, or predators already present in the United States on other insects might attack the species introduced to control mesquite and reduce their effectiveness. This is especially true for stem-boring larvae whose parasites are often not limited to a given species or even a genus but are more likely habitat specific (P.M. Marsh, Syst. Ent. Lab., USDA-ARS, Beltsville, MD, personal communication). On the other hand, if phytophagous organisms are introduced without their own natural enemies, they would be expected to increase to a higher level and give better control than in Argentina.

Second, mesquite in North America already has a complement of native insects that have evolved with it. Most introduced insects, therefore, will not be filling an empty ecological niche and may face competition from insects already present. Of course, some introduced species might find empty niches or might win the competition and produce better control than the native species.

Third, the control agents cannot be expected to limit their attack to only the two weedy target species, since they were collected from a different species of mesquite in South America (the North American species of mesquite, except for *P. reptans*, do not occur in South America). At this stage of the investigations, we cannot predict the degree to which a candidate insect would attack the target species (*P. glandulosa* and *P. velutina*) or species of *Prosopis* that are not primary targets. However, previous work indicates that many insects that feed on species in section *Algarobia* do not feed on species in section *Strombocarpa* (DeLoach 1982, 1983). Careful testing would be required, of course, before the release of any South American insects to determine the degree of feeding that might occur on other species of *Prosopis*.

Some investigators have recently questioned the propriety of attempting biological control of native plants, especially species such as mesquite that are dominants in certain biomes. Ecological conflicting interests arise in the belief that all elements of an ecosystem are interrelated and that removal of a plant species from an area, especially a native species, will trigger some unknown or unwanted reaction (Andres 1981). Johnson (in press), analyzed the effects of several drastic reductions in plant abundance

(both native and introduced plants) caused by accidental introductions or biological control agents. He concluded that the ecosystem is very strong and resilient and that ecosystem function is unlikely to be affected to any important extent by changes in species composition. He stated that the prevailing views of plant ecologists today are more in line with the individualistic concept of plant community structure than with the theory of a delicately balanced, all-parts-essential, ancient-in-age climax vegetation. He cautioned that the attempted biological control of a native weed species should include detailed and careful analyses of the benefits and losses that would arise both in regards to human use of the plant and to specific aspects of the plant and animal communities. These losses could be drastic, even though general ecosystem harm was not anticipated.

A level of control sufficient to return mesquite to its original density of the early 1800's would appear to be ecologically desirable and acceptable to the livestock industry as well. Just how much reduction would be required to achieve original densities is a matter of conjecture, because original densities are not known. However, we can probably assume that a 75–80 percent reduction in present stands would not be too much. Biological control is unlikely to achieve a reduction greater than this, especially with the introduction of only one or two insect species; additional species could be introduced later if additional control were desired.

Integrated Control Measures

Less than complete control by an introduced insect or pathogen might be satisfactory if its use is integrated with that of other control methods. Even moderate suppression of seedlings might greatly reduce the rate of invasion if coupled with suppression achieved by proper grazing management that allows strong competition from grasses. Partial control that slowed the rate of reinfestation so that chemical or mechanical controls need be repeated only each 15 years instead of the present 7–8 years would be very beneficial.

An introduced control agent is unlikely to reduce stands in areas where mesquite has recently invaded and leave the original areas untouched. Also, such an agent is unlikely to kill trees in pastures and not harm trees desired for shade or ornamentals. However, some degree of selection can be made depending on which control agent is used. For example, insects that feed on flowers, seed, or small plants would reduce the spread of mesquite into new areas but would not harm shade trees or several other beneficial uses of mesquite. Seed-feeding insects of long-lived perennial plants have long been considered to be ineffective biocontrol agents (Huffaker 1959). However, Harley (in press) discussed the use of flower- and seed-feeding insects to control woody weeds. Also, the intro-

duced shrub *Hakea sericea* has recently been controlled by an introduced seed-feeding weevil in South Africa (Nesser and Kluge, in press). We found several species of insects in South America that attack only flowers, fruit, or seed, but we found none that attack only young plants. Chemicals or other controls to protect nurseries or other desirable plantings from introduced insects could be developed before the release of those insects.

Conclusions

Several species of insects from Argentina and Paraguay severely damage species of *Prosopis* that are closely related to the North American weedy species. They comprise two species of still unidentified gelechiid leaf tiers, two species of geometrids, a sawfly, and one or more species of psyllids, all of which feed on foliage; several species of cerambycids whose larvae bore in branches or trunks or girdle large limbs, and a tiny cynipid wasp that attacks the limbs; and several species of bruchid beetles, small weevils of the genera *Apion* and *Sibinia*, a few cerambycids, and a few lepidopterous larvae that feed on the fruit and seed. These species would appear to give substantial control of mesquite if introduced into North America. Before any of these can be introduced, however, careful laboratory testing must be carried out to determine the degree of feeding likely to occur on the target species and other related species of *Prosopis* and to assure that beneficial plants will not be damaged. Additionally, conflicts of interest between groups who regard mesquite as harmful and want it controlled (Scifres et al. 1973) and groups who regard it as beneficial and do not want it controlled (Parker 1982) must be resolved (DeLoach, in press). Also, Mexican approval will be required for the release of any insects. Mesquite occurs in much of northern Mexico; and any insects released in the United States would likely spread into Mexico, where biological control would pose similar conflicts of interest as those in the United States (DeLoach et al., in press).

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Table 1

Phytophagous insects collected from *Prosopis* spp. in Argentina and Paraguay from 1976 to 1981, and reported by other workers

Prosopis species and No. of insects collected ²											
Series Chilesenses											
Insect name	Data source ¹	nigra	alba	chilensis	flexuosa	alpataco	caldena	affinis	strombulifera	Other named species ³	Host species ident. in other spp. genera ⁴
Abundance (No. insects/ collection method) ⁵											
No. sites where coll. collected ⁶											
Country and No. of Prov. where coll. collected ⁶											
Attack site or mode											
Stage coll. ⁷											
Coleoptera											
Alleculidae											
<i>Lobopoda</i> sp.	W		X								Arg
Anobiidae											
<i>Petalium</i> sp.	CD	2									
<i>Tricorynus argentinus</i> (Pic)	CD	1				10		2			1 Arg-1 5 Arg-5
											2/150sw 11/3h, 1/150sw
<i>T. subruficeps</i> (Pic)	V	X	X								Arg-7
<i>T. sp. a</i>	B,W,V	X	X								Arg-5
<i>T. sp. b</i>	CD	2									Arg-1,Par
	CD				1			3			2 Arg-2 2 Arg-2
Anthicidae											
<i>Anthicus</i> sp.	W										Arg
Anthribidae											
<i>*Anthribus</i> sp.	CD	11									1 Arg-1
<i>Piesocorynus</i> or nr.	CD	1									1 Arg-1
Bostrichidae											
<i>Micrapate wagneri</i> Lesne	H,V V	X					X				Arg-3 Arg-1
<i>M. sp.</i>											Arg-2,Par, Braz Arg,USA
<i>Tetrapriocera defracta</i> Lesne	V	X					X				Arg-12
<i>Xylobiops</i> spp.	W										Dead trunk Cut branch Dead wood Branch
<i>*Xyloprista hexacantha</i> (Faim.)	H,W,V	X	X			X	X				other hosts
Bruchidae											
<i>Acanthoscelides longiscutis</i> (Pic)	CD		1	3	286						5/100sw, 281/4h
	B,H,K, W,V										7 Arg-4 Arg-6,Bol
<i>A. sp. j</i> (undescribed)	K										Seed
<i>A. sp. k</i> (undescribed)	K	X									Seed
<i>A. spp.</i> (undescribed)	CD	15	4	5	arg-1						Seed Seed
											12 Arg-4
											<i>Lippia, Aloysia, A. caven</i>
											A

Phytophagous insects collected from *Prosopis* spp. in Argentina and Paraguay from 1976 to 1981, and reported by other workers—Continued

Prosopis species and No. of insects collected²

Series Chilenses

Insect name	Data source ¹	<i>nigra</i>	<i>alba</i>	<i>chilensis</i>	<i>flexuosa</i>	<i>alpato</i>	<i>caldia</i>	<i>affinis</i>	<i>ruscillera</i>	Other named species ³	Un-ident. spp. genera ⁴	Host species ident. in other spp. genera ⁴	Abundance (No. insects/ collection method) ⁵	No. sites where coll.	Country and No. of Prov. where collected ⁶	Attack site or mode	Stage coll. ⁷
* <i>Chalcopoeicila ornata</i> (Gory)	V	X	X									A. caven, Larrea sp.		Arg-6		Living wood	
<i>Chrysobothris furcata</i> Kerr.	V	X						X						Arg-2		Dead wood	
* <i>Paracuris bimaculata</i> (Gory)	V	X	X								X	C. aphylla		Arg-6		Branch, trunk	A
<i>Psiloptera corynthia</i> (Fairm.)	H,W,V	X	X								X	C. aphylla		Arg-6		Branch, trunk	
<i>P. desmaresti</i> Thoms.	B,H,W,V	X	X								X	A. caven		Arg-4		Branch, trunk	
<i>P. esterensis</i> Obenberger	B,W,V	X	X								X	A. caven		Arg-8,Chi		Branch, trunk	
<i>P. plagiata</i> (Gory)	B,W,V	X	X								X	A. caven, Condalia, Gossypium		Arg-9		Branch, trunk	
<i>P. tucumana</i> (Guer. & Perch.)	B,H,W,V	X	X								X	A. caven, Condalia, Gossypium				Branch, trunk	

Cerambycidae

<i>Achryson lutarium</i> Burm.	B, W, V	X	X									X			Arg-11, Uru, Braz, Par	Large branch	
<i>*A. surinamum</i> (L.)	B, H, W, V	X	X									X	<i>Celtis</i> , <i>Nectandra</i> , <i>Robinia</i> , <i>A. spp.</i> , <i>A. caven</i> , <i>Tamarindus</i> , <i>Ficus</i> , others		Arg, C. Am., S. Am., Mex, USA	Branch	
<i>A. undulatum</i> Burm.	B, W, V	X	X									X			Arg-9, Uru	Branch	
<i>A. unicolor</i> Bruch	B, W, V	X	X									X			Arg-10, Uru	Branch	
<i>*Alphus bruchi</i> Meizer	V	X										X			Arg-6	Trunk	
<i>A. sp. nr. bruchi</i> Meizer	CD											X			1		A
<i>*Brasilius lacordairei</i> Gahan	CL, E, H											X	<i>Schinopsis</i> spp.		Arg, Braz	Branch	
<i>*Calocosmus desmaresti</i> (Guer.)	B, W, V, H	X	X									X	<i>A. caven</i> , <i>Geoffroea</i>		Arg-9, Bol, Peru	Branch, trunk	
<i>*C. morosus</i> White	B, CL, W, V	X	X									X			Arg-7, Bol, Braz, Peru	Branch, trunk	
<i>*Coremia</i> sp.	W											X			Arg	Trunk	
<i>*Cnodon cinereum</i> (Olivier)	E											X			Arg	Trunk	
<i>*Cynoderus</i> sp.	CD											X			1		A
<i>*Cyllene spinifera</i> Newman	B, H, W, V	X	X									X			Arg-11, Uru, Chi	Branch, trunk	

* <i>Leptostylus</i> prob. <i>phryssominus</i> Bates	CD	3	8		3	14/4h	4	Arg-2,Par	Seed	L
<i>L. phryssominus</i> Bates	CD				25	25/2h	1	Arg-1	Seed	L,P
<i>L. sp.</i>	CD				1				Fruit	L
<i>Lochmaeocles sladeni</i> (Gahan)	V				X				Girdle	
* <i>Lophopoeum tinbouvae</i> Lameere	B,V,W	X			X				branch	
<i>L. sp.</i>	CD					1/0.5h	1	Par	Seed	L
<i>Odontocera flavicauda</i> Bates	V	X	1					Arg-2,Par, Braz,Uru	Girdle	
<i>Oncideres germani</i> Thoms.	B,W,V	X			X			Arg-12,Uru, Braz	branch	
<i>O. guttulata</i> Thoms.	CD	2			3		3	Arg-2	Girdle	A
	B,W,V	X						Arg-10,Uru	branch	
<i>O. sp.</i>	W									
* <i>Raqueles mus</i> Gounelle	B	X		X				Arg	Stem	
<i>Rhopalophora iridipennis</i> (Chevr.)	V	X						Arg-4	Living	
* <i>Torneutes pallidipennis</i> Reiche	B,V							Arg-4	trunk	
								Arg-12,Uru	Trunk,	
								Par	limbs	
<hr/>										
Chrysomelidae										
* <i>Acanthonychia</i> sp. or nr.	CD					1/100sw	1	Arg-1		A
<i>Babia elongata</i> J. Guerin	CD	1				1/3b	1	Arg-1		A
<i>Chrysodina semiaurata</i> Lefev.	W	X						Arg-9		
<i>C. sp.</i>	CD					1/2b	1	Arg,Braz		A
<i>Colaspis</i> sp. nr. <i>concoloripes</i> Bechyne	W	X	1					Arg-1		
<i>C. lebasii</i> Lefv.	W		X					Arg		
<i>C. varia</i> Lefv.	CD					2/3b	1	Arg,C.Am.		
	B		2					Arg-1		A
								Arg-6,Uru, Braz		A
<i>C. sp.</i>	CD					4/230sw,1/3b	3	Arg-3		A
<i>Coscinoptera argentina</i> Burm.	V	X	2	3				Arg-3,Uru	Leaves	A
<i>C. dubia</i> L. Guerin	V	X						Arg-3	Leaves	A
<i>Cryptoccephalus</i> sp.	W	X		X				Arg		
* <i>Cylindrodachrys cleroides</i> Montrós	V	X						Arg-4,Par	Leaves	A

See footnotes at end of table.

Table 1

No. of insects collected	Other named species ³
1	<i>ruscilia</i>
1	<i>strombilleria</i>
1	<i>vin-1</i>
1	<i>toq-1</i>
2	
21	<i>toq-1</i> , <i>vin-5</i> , <i>ela-1</i> , <i>fie-1</i> , <i>has-1</i>

P. n. spp. a-e	CD	7	11	31	12	54	A. caven	84/1050sw, 31/7b	13	Arg-7	A
<i>Promecops</i> spp. a-d	CD	2	1	2	22	has-1, vin-3	A. aroma	24/450sw, 7/3h	6	Arg-3,Par	A
* <i>Promecopini</i> n. gen n. sp.	CD	1						3/3b	2	Arg-2	A
* <i>Rhigopsidius tucumanus</i> Heller	CD B,H	2				1	2	1/100sw,2/3b	2	Arg-2	A
<i>Sibinia algarobilla</i> n. sp. Clark	CD						<i>Solanum pocote</i> , <i>S. tuberosum</i>	5/50sw 3/100sw	1 3	Arg-5,Chi, Bol,Peru	Root Bud Seed
<i>S. concava</i> Clark	CD	1		5		18		6/450sw 18/100sw	5 1	Arg-4 Arg-1	Bud Seed
<i>S. mastuerzo</i> n. sp. Clark	CD							14/150sw	2	Arg-2	Bud
<i>S. tintitaco</i> n. sp. Clark	CD	1						1/1h	1	Arg-1	Seed
† <i>Sitophilus granarius</i> (L.)	CL						Stored seeds of several cereals			Cosmopolitan	
* <i>Wagneriella alba</i> Hust.	CD	3			14	3	A. caven,	20/650sw	7	Arg-4	A
* <i>W. lineata</i> Hust.	V	X	X		X		A. aroma				
* <i>W. sp.</i>	CD				1		A. caven	1/3b	1	Par	Leaves
Dermeidae											A
<i>Attagen</i> sp.	CD		2	1				3/170sw	2	Arg-2	A
<i>Cryptorhopalum</i> sp.	CD			1			<i>Aloysia</i> <i>gratissima</i>	1/100sw	1	Arg-1	A
<i>Trogoderma</i> sp.	CD			2		arg-1		3/170sw	2	Arg-2	A
Elatenidae											
<i>Conderus malleatus</i> Ger.	CD CL,H	2					<i>Psidium guajava</i> , <i>Prunus</i> sp., <i>Pyrus malus</i> , <i>Eucalyptus</i> sp., <i>Ipomoea batatas</i> , grasses	2/100sw	1	Arg-1	Fruit
<i>C. rufangulus</i> (Gyll.)	W						X	1/2b	1	Arg-1	A
<i>Horistonotus</i> nr. <i>spemendus</i> Ef.	CD		1								
Languriidae											
<i>Hapalips</i> sp.	CD			2			A. caven	2/1h	1	Arg-1	Seed
Lycidae											L
<i>Trogoxylon ingae</i> Santoro	V	X								Arg-11	Stem
Meloidae											A
<i>Epicauta adspersa</i> (Klug)	W						X			Arg,Uru	A
<i>E. atomaria</i> (Germar)	CD B,H	3						3/1b	1	Arg-1	A
							<i>Nicotiana</i> sp., <i>Solanum</i> spp., <i>Lycopersicon</i> , <i>Capsicum</i>			Arg-10	Leaves
<i>E. sp.</i>	CD				4			4/3b	1	Par	A

See footnotes at end of table.

Prosopis species and No. of insects collected²

Prosopis species and No. of insects collected ²																	
Series Chilenses																	
Insect name	Data source ¹	nigra	alba	chilensis	flexuosa	alpataco	caldenia	affinis	strombulifera	Other named species ³	Un-ident. spp.	Host species ident. in other genera ⁴	Abundance/ collection method ⁵	No. sites where coll.	Country and No. of Prov. where collected ⁶	Attack site or mode	Stage coll. ⁷
Melyridae																	
nr. Amecocerus spp. a-c	CD			7	17	2			1				27/540sw	6	Arg-4		A
Astylus sp.	CD						1						1/1h	1	Arg-1		A
Artalus sp.	CD				1								1/100sw	1	Arg-1		A
Collops sp.	CD									has-1			1/1h		Par		A
Mordellidae																	
Mordella sp.	CD						1						1/1h	1	Arg-1		A
Mycteridae																	
Polyprya sp.	CD								2				2/3b	1	Par		A
Nitidulidae																	
†Carpophilus hemipterus (L.)	W										X				Arg, Chi, Mex, C. Am, N. Am, Europe	Seed	L
C. humeralis (F.)	CD	1											1/1h	1	Arg-1		L
Lobiopa sp.	W		X										1/1h	1	Arg-1		A
nr. Platychora	CD				1								2/1h	1	Arg-1		A
Soronia nr. rectangula Reitt.	CD				1												A
Ptinidae																	
Ptinus sp.	CD				1	1							1/3b, 1/70sw	2	Arg-2		A
Scarabaeidae																	
Euphoria spp.	B, W										X				Arg		
*Homonyx chalcea Blanchard	B, W										X				Arg		
*H. chalcea var. fuscocupreus	B, V		X								X				Arg-3		
Ohaus																	
Tenebrionidae																	
*Epitragus aurulentus Kirsch	CD								1				1/2b	1	Par		A
*E. similis Steinh.	CD	1	X						1				3/6b	3	Arg-2, Par		A
	B, H, V											A. caven, Condalia, Gossypium sp.			Arg-9, Bol		L
*E. sp. nr. similis Steinh.	CD	1											8/7b	3	Arg-1		A
*E. sp.	CD	3											3/30sw	1	Arg-1		A
*Hemasodes sp.	CD												1/2b	1	Arg-1		A
*Omophres bacchulus Berg	CD												5/5b	2	Arg-2		A
	W										X				Arg		

*O. spp. a.b	CD	3	6	1	1/2b	1	Par	A
<i>Strongylium</i> sp.	CD			1	1/2b	1	Par	A
* <i>Thinobatis</i> sp.	W						Arg	
Trogositidae								
nr. <i>Eronyxa</i> sp.	CD		1		1/100sw	1	Arg-1	A
<i>Tenebroides</i> sp.	W			X			Arg	
Diptera								
Agromyzidae								
<i>Melanagromyza</i> sp.	CD	1			1/150sw	1	Arg-1	A
<i>Phytobia</i> sp.	W			X			Arg	
Anthomyiidae								
<i>Craspedochaeta punctipennis</i> (Wied.)	CD		2		2/200sw	1	Arg-1	A
<i>Delta platyura</i> (Meigen)	CD CL	5	1		6/230sw	3	Arg-2 Bot	A L
Cecidomyiidae								
* <i>Liabelicia prosopidis</i> (Kieffer & Jörgensen)	J			X			Arg-2	Branch gall
<i>Neolasioptera graciliforceps</i> (Kieffer and Jörgensen)	J			X			Arg-2	Twig gall
<i>Rhopalomyia prosopidis</i> (Kieffer & Jörgensen)	J		X				Arg-2	Gall
* <i>Tetradiplosis sexdentatus</i> (Kieffer & Jörgensen)	J	X	X				Arg-2	Branch and thorn gall
Chloropidae								
<i>Chlorops</i> n. sp.	CD		1		1/200sw	1	Arg-1	A
<i>C. mendozae</i> Mall.	CD	15	1		16/200sw	2	Arg-2	A
<i>C. nr. mendozae</i> Mall.	CD			2	2/100sw	1	Arg-1	A
<i>Conioscinella</i> sp.	CD		1		1/50sw	1	Arg-1	A
<i>Elachiptera sacculicornis</i> (End.)	W	X					Arg	
<i>Liohippelates aequatorialis</i> (Becker)	W	X					Arg	
<i>L. n. sp.</i>	CD	4		1	4/50sw, 1/3b	2	Arg-2	A
<i>L. sp.</i>	CD				1/50sw	1	Arg-1	A
<i>Olfella</i> sp.	CD		1		1/50sw	1	Arg-1	A
<i>Oscinella</i> sp.	W						Arg	
<i>Oscinella</i> sp.	W	X					Arg	
Empididae								
<i>Drapetis</i> sp.	CD		7		7/70sw	1	Arg-1	A
Lonchaeidae								
<i>Dasiops</i> sp.	CD		2	3	5/200sw	2	Arg-1	A

See footnotes at end of table.

Table 1

Phytophagous insects collected from *Prosopis* spp. in Argentina and Paraguay from 1976 to 1981, and reported by other workers—Continued

Prosopis species and No. of insects collected ²										
Series Chilesenses										
Insect name	Data source ¹	nigra	alba	chilensis	flexuosa	alpatenco	caldenia	affinis	ruscifolia	strombulifera
Tephritidae										
<i>Euaresta bullans</i> (Wied.)	CD	1								
<i>E. sp.</i>	CD	1					2			
<i>Tomoplagia heringi</i> Aczel	W	X								
<i>T. sp.</i>	CD							1		
<i>Trupanea</i> sp.	CD			1						
† <i>T. mevarna</i> (Walk.)	W								X	
Hemiptera										
Coreidae										
† <i>Leptoglossus phyllopus</i> (L.)	W								X	
* <i>Pachylis argentinus</i> Berg	W								X	
Lygaeidae										
<i>Lygaeus alboornatus</i> Blanchard	W								X	
Miridae										
<i>Cercatapsus</i> sp.	CD	1	1	2						
* <i>Haarupia spinosa</i> Poppius	CD	1						3		
	W	X					X			
* <i>H. sp.</i>	W						X			
<i>Orthotylus</i> sp.	W	X	X				X			
<i>Phytocoris</i> sp.	W	X					X			
									X	rub
Pentatomidae										
<i>Acledra</i> sp. (?)	W									
* <i>Lobopornis peltifera</i> Berg	CD	3		3			1		X	
	W									
† <i>Oebalus pugnax</i> (F.)	W	X							X	Rice
<i>Thyanta aeruginosa</i> Berg	W									
<i>T. elegantula</i> Haar	W	X							X	
Rhopalidae										
<i>Arhyssus</i> sp.	W	X								
<i>Harmostes imitabilis</i> Harris	W								X	
<i>H. sp.</i>	CD							1		
<i>Liorhyssus</i> sp.	W								X	

Table 1
Phytophagous insects collected from *Prosopis* spp. in Argentina and Paraguay from 1978 to 1981, and reported by other workers—Continued

Prosopis species and No. of insects collected ²																	
Series Chilenses																	
Insect name	Data source ¹	nigra	alba	chilensis	flexuosa	alpalaco	caldenia	affinis	ruscullifera	Other named species ³	Un-ident. spp. genera ⁴	Host species in other genera ⁴	Abundance (No. insects/ collection method) ⁵	No. sites where coll. collected ⁶	Country and No. of Prov. where collected ⁶	Attack site or mode	Stage coll. ⁷
*Hebetica arechavaeleta (Goding)	CD	12	2	2	1	1	2	5					25/1250sw	16	Arg-7		A
*H. limacodes (Burmeister)	CD	1						1					2/150sw	2	Arg-2		A
*Nassunia bipunctata (Fairmaire)	CD		1										1/100sw	1	Arg-1		A
*Smiliorachis nr. concinna Stål.	CD		11					3					14/200sw	2	Arg-1		A
*S. proxima Berg	CD H,W	9 X	2 1	1 1				5				A. caven, Mimosa	18/820sw	8	Arg-6 Arg,Braz, Col,Uru		A
Stictopelta acutula (Fairmaire)	CD CL	2 CL	2 1	1 11									16/320sw	4	Arg-4 Braz		A
S. flaviceps (Burmeister)	CD W	X		1							Solanaceae		1/100sw	1	Arg-1 Arg,Braz, Ecu,Uru		A
S. indeterminata (Walker)	CD	6	7	1	3		25	4	4			Acacia aroma, A. caven, A. sp.	50/1270sw	14	Arg-6		A
*Sundarion apicalis (Germar)	W CD	1						1			X Acacia sp. A. caven		2/150sw	2	Arg, C,Am,Mex Arg-2		A
Psyllidae																	
Euphalerus sp.	W	X	X				X				X				Arg		
nr. Euphalerus spp. a-d	CD	53	29	3	22	4	1		3	toq-1			7/5b, 109/1200sw	19	Arg-5		A
Hymenoptera																	
Cynipidae																	
*Eschatocerus myriadeus Kieffer & Jörgensen	CD	X											100+ branches on each tree infested and killed	2	Arg-2	Branch gall	L,P
	J						X			cam					Arg-1	Branch gall	
*E. niger Kieffer & Jörgensen	J,H,W	X	X		X					cam					Arg-2	Branch gall	
*E. sp.	CD			X											Arg-1	Branch gall	A

Table 1

Phytophagous insects collected from *Prosopis* spp. in Argentina and Paraguay from 1976 to 1981, and reported by other workers—Continued

Prosopis species and No. of insects collected ²																		
Series Chilenses																		
Insect name	Data source ¹	nigra	alba	chilensis	flexuosa	alpataco	caldenia	affinis	ruscilia	strombilitera	Other named species ³	Un-ident. in other spp. genera ⁴	Host species in other genera ⁴	Abundance (No. insects/ collection method) ⁵	No. sites where coll.	Country and No. of Prov. where collected ⁶	Attack site or mode	Stage coll. ⁷
Lycaenidae																		
<i>Ministrymon</i> sp.	Rob											X		1/50sw	1	Arg		A
<i>Strymon eurytulus</i> (Hbn.)	CD															Arg-1		
Megalopygidae																		
<i>Norape</i> spp. a,b	CD		2					1						3/300sw	2	Arg-2		L
* <i>Podalia nigricostata</i> Dognin	H	X	X										Acacia spp., Neptunia sp., Robina, Tipuana sp., Geoffroea sp., Mimosa sp.			Arg	Leaves	L
Noctuidae																		
† <i>Ascalapha odorata</i> (L.)	H,B											X	Piptadenia, Pterogyne, Cassia, Acacia spp., Ginga sp. A. aroma	96% ^a		Arg	Leaves	
<i>Melipotis bisinuata</i> (Felder & Rogenthoefer)	R					61	242							100% ^a		Arg		
Noctuidae sp. a	R					29						X	Sesbania exarferata	1/1h	1	Arg-1, USA		L
<i>Selenisa suero</i> (Cramer)	W,H																	
† <i>S. sueroides</i> (Guenée)	CD		1															
Oecophoridae																		
<i>Cecidblechia maculicostella</i> Strand	J,H	X				X			cam							Arg-2	Flower gall	L
Psychidae																		
<i>Oiketicus bergii</i> (Weyenbergh)	CD	10		53	75	10							A. aroma, Larrea, Cercidium, Mimozgyanthus			Arg-4	Leaves	L,A
												X	C. aphylla			Arg	Leaves	
<i>O. geyeri</i> Berg	W												A. aroma, Mimosa, Cercidium	67% ^a		Arg	Leaves	
	R			X	X													
<i>O. horni</i> Koehler	W											X	Piptadenia spp.			Arg	Leaves	
<i>O. westwoodii</i> Berg	W											X				Arg	Leaves	

Pyrilidae													
<i>Anypsipyla univittella</i> Dyar	CD	10	2	3				kun-7, abb-1, fie-2	25/10h	11	Arg-5,Par	Seed	L,P,A
	CL												
† <i>Cadra cautella</i> (Walker)	CD	5	15	2	7	1	1	arg-2, kun-1, toq-2	5/3b,41/8h	10	Arg-8	Seed	L
	CL												
† <i>Ectomyelois ceratoniae</i> (Zeller)	CD	2						kun-6	8/3h	3	Arg-2	Seed	L,P
	W							jul					
† <i>Pyralis farinalis</i> L. (prob.)	CD CL,H							kun-1	1/1h	1	Arg-1 Cosmo- politan	Seed	L
Saturniidae													
<i>Adeloccephala</i> sp.	CD						2		2/3b	1	Arg-1		L
<i>Automeris aspera</i> (Felder)	H,Bi,W	X	X								Arg,Uru,Braz, Par		
<i>A. oberthuri</i> (Boisduval)	H,W	X	X								Arg	Leaves	L
<i>Citheronia</i> sp.	CD								1/50sw	1	Arg-1		L
<i>Hylesia</i> sp.	CD						1	ser-1	3/lb	1	Arg-1	Leaves	L
<i>Sphingicampa lineata</i> (Dognin)	W,H	X	X								Arg		L
<i>Sysphinx formosa</i> Dognin	W,J										Arg		L
Sesiidae													
<i>Sesia</i> sp.	CD		1						1/1h	1	Arg-1	Twig	L
<i>Synanthedon</i> sp. nr. <i>sciophilaeformis</i>	CD			1					1/1h	1	Arg-1	gall Twig	L
Tortricidae													
* <i>Cryptophebia carpophagoides</i> Clarke	CD	1					1		2/2h	2	Arg-1,Par	Seed	L
<i>Cydia</i> sp.	CD		9						9/2h	1	Arg-1	Twig gall	L

Table 1

Phytophagous insects collected from *Prosopis* spp. in Argentina and Paraguay from 1976 to 1981, and reported by other workers—Continued

Prosopis species and No. of insects collected ²									
Series Chileses									
Insect name	Data source ¹	alba	chilensis	flexuosa	alpataco	caldena	affinis	ruscullia	strombulfiera
Genus and sp. a	CD		1						
Genus and sp. b	CD				1	1	7		
Thysanoptera									
Thripidae									
<i>Frankliniella rozeos</i> Moulton	E, W								
Acarina									
Eriophyidae									
<i>Eriophyes</i> poss. <i>tenuis</i> (Nal.)	CD								

¹B = Bosq (1943); Bi = Biezanko et al. (1957); CD = Cordo and Deloach (or Cordo alone or with Ferrer); CL = Costa Lima (1968); E = Erb; H = Hayward (1958); J = Jörgensen (1976); K = Kingsolver et al. (1977); Kingsolver (1968, 1982, 1983); L'Argentier and Kingsolver (1984); O = Orfila (1966); R = Cates and Rhoades (1977); Rob = R.K. Robbins (pers. comm.); V = Viana; W = Ward et al. (1977).

²X indicates occurrence on a given species of mesquite reported by other authors who did not give numbers collected or indication of abundance; numbers are total number of specimens we collected.

³Species of *Prosopis*: abb = *abbreviata*, arg = *argentina*.

cag = *calingastana*, cam = *campestris*, ela = *elata*, fer = *ferox*,

fie = *fieligii*, gland = *glandulosa*, has = *hassleri*, hum = *humilis*,

jul = *juliflora*, kun = *kuntzei*, pan = *alba* var. *pantia*, rep = *reptans*,

rub = *rubriflora*, ser = *sericantha*, toq = *torquata*, vin = *vinallio*.

⁴A. = *Acacia*, C. = *Cassia*.

sb = number of sheets by beating, h = hours searching by hand, sw = number of sweeps

⁵Arg = Argentina, Braz = Brazil, Bol = Bolivia, C.Am = Central America, Chi = Chile, Col = Colombia, Ecu = Ecuador, Mex = Mexico, N.Am = North America, Par = Paraguay, S.Am = South America, Uru = Uruguay, USA = United States.

⁷A = adult, L = larva, N = nymph, P = pupa.

⁸Percent preference scores of feeding on *Prosopis* spp. among all plants examined (Cates and Rhoades 1977).

⁹Genus given does not occur in North America; however, taxonomic revision would probably reveal that this species should be placed in another genus (taxonomists of the USDA-ARS Systematic Entomology Laboratory, pers. comm.).

*Signifies that the insect genus is not represented in North America; †indicates that the insect species occurs in North America, according to taxonomists of the USDA-ARS Systematic Entomology Laboratory.

Table 2

Priority biological control candidates for mesquite, all of which were collected at several sites and/or are at least moderately abundant

A. Probably specific, cause obvious damage			B. Possibly specific, definite association with <i>Prosopis</i> , damage not obvious, or unknown		
Coleoptera			Coleoptera		
Bruchidae			Anobiidae		
<i>Acanthoscelides logiscutus</i>	Seed		<i>Tricorynus subrutilliceps</i>	Fruit	
<i>A. spp. j, k</i>	Seed		Cerambycidae		
* <i>Pectinibruchus longiscutus</i>	Seed		<i>Leptostylus</i> prob. <i>phryssomimus</i>	Pods	
* <i>Rhipibruchus picturatus</i>	Seed		Chrysomelidae		
* <i>R. prosopis</i>	Seed		<i>Megalostomis</i> sp. nr. <i>consimilis</i>		
* <i>R. psephenopygus</i>	Seed		<i>Pachybrachis</i> spp.		
* <i>Scutobrachus ceratioborus</i>	Seed		* <i>Temnodachrys aenofasciata</i>		
* <i>S. curtitropis</i>	Seed		Curculionidae		
* <i>S. terani</i>	Seed		<i>Pandeletelus platensis</i>	Roots?	
Cerambycidae			* <i>Pororrhynchus</i> spp.	Roots?	
<i>Achryson lutarium</i>	Large limbs		Melyridae		
<i>A. undulatum</i>	Limbs		nr. <i>Amecocerus</i> sp. a		
<i>A. unicolor</i>	Limbs		Tenebrionidae		
* <i>Alphus bruchi</i>			* <i>Omophres bacchulus</i>		
* <i>Calocosmus morosus</i>	Limbs		Hemiptera		
* <i>Clodion cinereum</i>	Trunk		Pentatomidae		
* <i>Cyllene spinifera</i>			* <i>Lobopomis peltifera</i>	Pods	
<i>Lochmaeocles sladeni</i>	Girdles lg branches		Homoptera		
<i>Odontocera flavicauda</i>	Girdles sm branches		Cicadellidae		
* <i>Ranqueles mus</i>	Trunk		<i>Polana obliqua</i>		
Curculionidae			* <i>Tapajosa doeringi</i>		
<i>Apion</i> sp.	Seed		Membracidae		
<i>Sibinia asulcifera</i>	Probably seed		* <i>Hebetica arechavaeleta</i>		
<i>S. concava</i>	Probably buds		* <i>Smillorachis</i> sp. nr. <i>concinna</i>		
<i>S. mastuerzo</i>	Probably seed		C. Known to attack other weed genera, cause obvious damage		
<i>S. tintilaco</i>	Probably buds		Coleoptera		
Homoptera			Anobiidae		
Psyllidae			<i>Tricorynus argentinus</i>	Fruit	
nr. <i>Euphalerus</i> spp. a-d	Foliage		Bruchidae		
Hymenoptera			* <i>Scutobrachus vinalicola</i>	Seed	
Cynipidae			Buprestidae		
* <i>Eschatocerus myriadeus</i>	Branches		* <i>Chalcopoeila ornata</i>	Trunk?	
Pergidae			Cerambycidae		
<i>Brachyphatnus</i> sp.	Foliage		* <i>Brasilianus lacordairei</i>	Branches	
Lepidoptera			* <i>Calocosmus desmaresti</i>	Limbs and trunk	
Gelechiidae			* <i>Lopopoeum timbouvae</i>	Fruit	
<i>Evippe</i> spp.	Leaf tier		<i>Oncideres germarii</i>	Small branches	
<i>Recurvaria-Aristotelia</i> sp.	Leaf tier		<i>O. guttulata</i>	Limbs	
Geometridae			* <i>Torneutes pallidipennis</i>	Trunk and lg limbs	
* <i>Narragodes</i> sp. prob. <i>gyda</i>	Foliage		Chrysomelidae		
* <i>Nephodia marginata</i>	Foliage		* <i>Cilindrodachrys cleroides</i>	Foliage	
Noctuidae			<i>Ischiopachys cribripennis</i>		
Genus and species undet.	Foliage		<i>Megalostomis gazella</i>		
Psychidae			<i>Pachybrachis</i> nr. <i>adspersa</i>	Foliage	
<i>Oiketicus horni</i>	Foliage		Curculionidae		
Acarina			* <i>Wagneriella alba</i>	Roots?	
Eriophyidae					
<i>Eriophyes</i> poss. <i>tenuis</i>	Foliage				

See footnote at end of table.

Table 2

Priority biological control candidates for mesquite, all of which were collected at several sites and/or are at least moderately abundant—Continued

Homoptera			
Cicadellidae			
<i>Gypona paupercula</i>	Leaves or twigs		
Membracidae			
<i>Stictopelta inderterminata</i>	Leaves or twigs		
Lepidoptera			
Geometridae			
<i>Semiothisa</i> sp.	Leaves		
Noctuidae			
<i>Melipotis bisinuata</i>	Leaves		
		Psychidae	
		<i>Oiketicus bergii</i>	Leaves
		<i>O. geyeri</i>	Leaves
		<i>O. westwoodii</i>	Leaves
		Pyralidae	
		<i>Anypsipyla univitella</i>	Pods
		Thysanoptera	
		Thripidae	
		<i>Frankliniella rodeos</i>	Flowers

*Signifies that the insect genus is not represented in North America.

Table 3

Amount of damage to *Prosopis* seed by bruchid larvae in field collections

<i>Prosopis</i> species	No. locations	No. seed examined	Percent damaged
<i>flexuosa</i>	7	1,798	24.1
<i>alpataco</i>	4	1,556	7.6
<i>alba</i>	4	698	29.4
<i>nigra</i>	3	600	14.7
<i>chilensis</i>	2	350	32.8
<i>caldenia</i>	6	1,765	35.5
<i>strombulifera</i>	6	1,532	7.5
<i>ruscifolia</i>	1	281	35.9

